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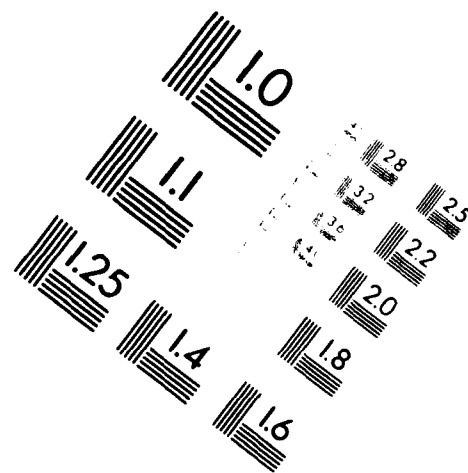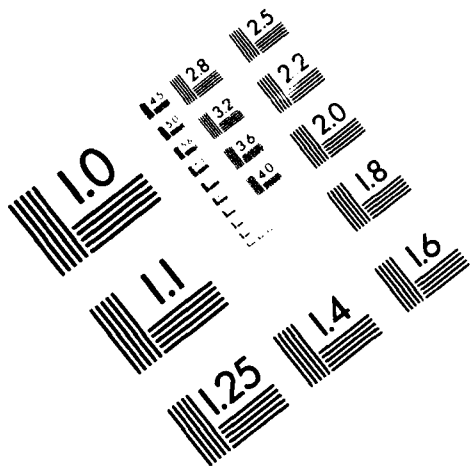
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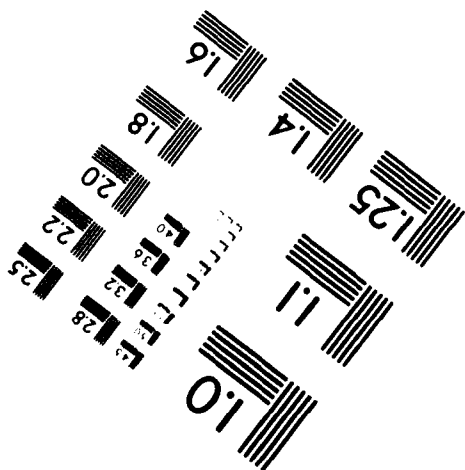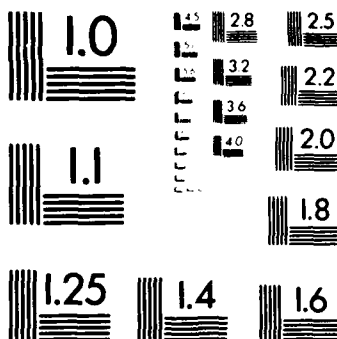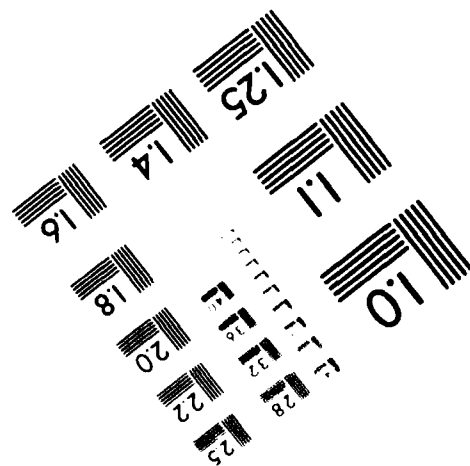
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REPORT DOCUMENTATION PAGE		
1a. REPORT SECURITY CLASSIFICATION		
2a. SECURITY CLASSIFICATION AUTHORITY		Approved for public release; distribution unlimited.
2b. DECLASSIFICATION DOWNGRADING SCHEDULE		

JUL 0 1 1994

4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
	AFOSR-TR· 94 0370

6a. NAME OF PERFORMING ORGANIZATION	6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION
Washington State University		AFOSR/NL

6c. ADDRESS (City, State and ZIP Code)	7b. ADDRESS (City, State and ZIP Code)
3935 University Way, N.E. Pullman, WA 99164-5045	Building 410 Bolling AFB DC 20332-6448

8a. NAME OF FUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
AFOSR	NL	F49620-92-J-0243

8c. ADDRESS (City, State and ZIP Code)	10 SOURCE OF FUNDING NOS.			
110 Duncan Ave Suite B115 Beiling AFB DC 20332-0001	PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO	WORK UNIT NO
	61103D	3484	54	

11. TITLE (Include Security Classification)
Augmentation of research on cognitive control

12. PERSONAL AUTHOR(S)
Paul Whitney

13a. TYPE OF REPORT	13b. TIME COVERED	14 DATE OF REPORT (Yr., Mo., Day)	15 PAGE COUNT
Annual Technical	FROM 5/9/3 TO 4/9/4	94-5-31	8

16. SUPPLEMENTARY NOTATION

DTIC QUALITY INSPECTED 2

17	COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB. GR	working memory, text comprehension, individual differences

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The influence of individual differences in working memory span (WMS) on comprehension of instructional text was examined. Results from the second year of the AASERT grant showed that readers across the range of WMS paid special attention to thematic statements when they read instructional texts. This was shown through longer reading times of sentences in the initial position of paragraphs. However, if comprehension of specific details was stressed by asking about details after each passage, then high WMS readers increased thematic processing in comparison to reading times obtained when the questions asked about topics and details. Low WMS readers did not increase thematic processing when details were stressed. The increased thematic processing by high WMS readers was associated with better comprehension of both topics and details on a later surprise test of learning. Higher WMS may allow some readers to use integrative strategies not available to other readers.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
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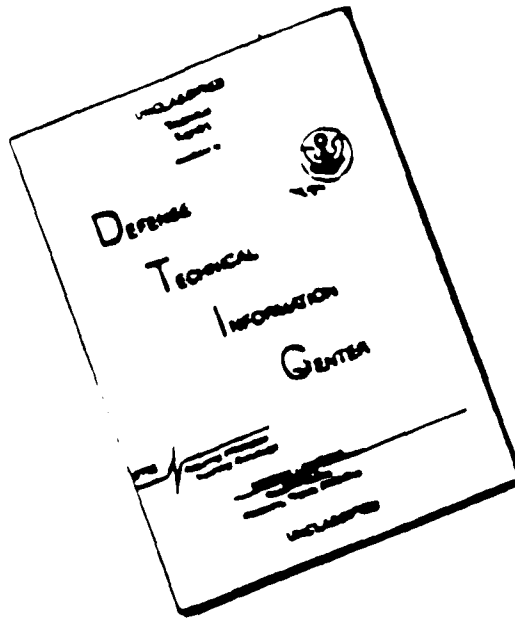
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Augmentation of Research on Cognitive Control

grant no. F49620-92-J-0243

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June 7, 1994

Annual Technical Report for May 1, 1993 - April 30, 1994

<u>Prepared for:</u>

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RESEARCH OBJECTIVES

The research supported by this grant is designed to uncover basic principles of cognitive control during the comprehension of expository text. Cognitive control refers to how individuals adapt their strategies for learning from text to both variations in text and to their own information processing limitations. In research in my own laboratory (e.g., Lee-Sammons & Whitney, 1991 and others (e.g., Just & Carpenter, 1992), it has been established that subjects read in a qualitatively different fashion if they are low in working memory (WM) capacity. The capacity of WM is measured as the subjects' ability to actively manipulate information in short-term memory. Previous research in this area has focused on narrative, or story-like, materials. This project focuses on expository text, which people read to learn specific information. Unlike narrative text, which follows a familiar organizational pattern, expository texts vary widely in their organizational schemes. This makes them useful for the study of how people flexibly allocate their WM resources during comprehension. In addition, by studying expository text, we may be able to uncover basic principles that can be applied to improving people's ability to learn from text. In the second year of the AASERT grant, Desiree Budd (the supported student) and I had two specific objectives in mind:

(1) We wished to establish whether readers that differ in WM capacity would vary in the adjustments they make to the types of comprehension questions that are asked.

(2) We wished to develop a theoretical framework that could account for control processes in comprehension without appealing to a homunculus-like central executive.

STATUS OF THE RESEARCH EFFORT

Tradeoffs in Expository Text Processing

Several current theories of text processing (e.g., van Dijk & Kintsch, 1983; Kieras, 1982) make a distinction between macroprocessing (keeping track of the theme of a text) and microprocessing (relating each sentence to the preceding sentence). We reasoned that subjects low in WM capacity (low spans) might face a tradeoff between these two types of processing. That is, they could track sentence-to-sentence connections and learn about the details of a passage, or they could determine how each sentence relates to the overall theme

and learn more about the topic of the passage. In contrast, high span readers were expected to perform both types of processing.

In the first year of the grant, we developed a set of expository passages with a simple hierarchical structure. That is, each passage began with a statement of the overall topic, and this was followed by six supporting detail sentences. The passages were adapted from various non-technical science and hobby magazines.

Research in the first year established that if subjects are probed during reading with questions about topics or details, both high and low WM capacity readers can answer topic probes quickly and accurately even several sentences after a topic sentence. This result suggests that both types of readers were maintaining thematic information in WM throughout comprehension. A second experiment showed that both high and low span subjects showed longer reading times to sentences in the first position in a paragraph. Kieras (1982) found that when subjects performed macroprocessing, the reading times to the first few sentences were increased in the topic absent condition as subjects either make use of or infer a topic. Thus, the results of our second experiment supported the interpretation of experiment 1: even low WM span readers were performing macroprocessing.

The research from the first year led directly to the research we completed in the second year. We extended the results of the second experiment noted above by testing 80 subjects in a procedure in which we measured sentence-by-sentence reading times to passages with or without topic sentences. At the end of a block of six passages, the subjects answered multiple choice questions about the topics and details of the passages. We took the amount of decrease in reading time over the first four sentence positions as an index of the amount of thematic processing performed by the subjects. As Figure 1 (on page 4) shows, there was no relationship between WM span and thematic processing in either the topic absent or topic present condition. However, Figure 2 shows that the extra difficulty of thematic processing without an explicit topic sentence is associated with poorer performance on detail questions for lower WM span readers. Thus, when thematic processing is made more difficult, lower span readers show a tendency to do more poorly on questions about specific details.

Figure 2: Performance on the multiple choice questions (means and standard errors).

Figure: Plot of PROPORTION CORRECT versus WORKING MEMORY SPAN, with dashed line labeled DETAIL and solid line labeled TOPIC.
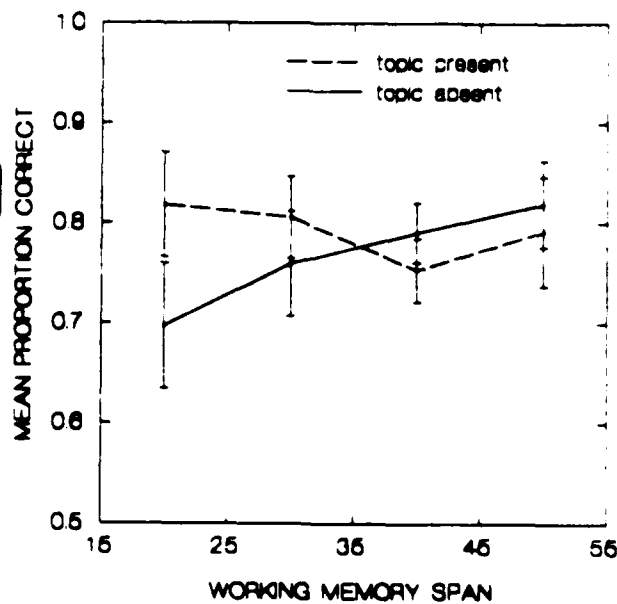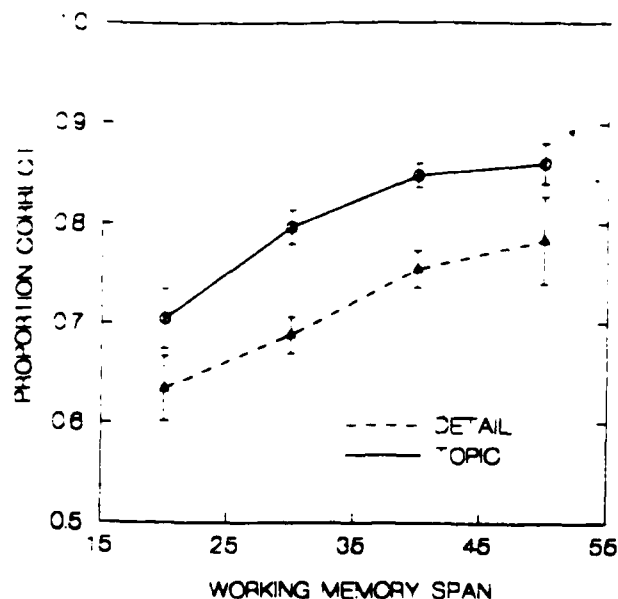
Theory Development

Several researchers in the area of text comprehension have claimed that skilled readers adjust their comprehension processes to fit the nature of the text they are reading and their current reading goals (e.g., Just & Carpenter, 1992; Vonk & Noordman, 1990). The adjustment of the comprehension system to such contextual constraints may also include adjustments by subjects to their own WM capacity. The raises the interesting theoretical question of how the comprehension system can be self-organizing to adapt to a variety of contextual constraints.

Often, the types of control processes that must be used to make adjustments to context are assigned vaguely to a "central executive." In contrast, we have developed a framework that will provide the basis for understanding how the information processing system could make context-sensitive adjustments, but it uses a distributed set of control processes. The architecture for this framework is a hybrid of a semantic network and a production system. We believe that it will be possible to go beyond describing the adjustments that readers make in context, and actually predict what types of adjustments will be made, and in what contexts. The model relates different areas of psycholinguistics together-- for example research on access to word meanings and research on logical inferences in text comprehension. In addition, our model makes testable predictions about what kind of information will be learned from a text depending on the skill of the reader and the goals of

We have also imple... an ... experiment in ... ...
replicated the first ... of ... ... the ... ...
experiment, was asked out ... ...
specific detail ... ... after each passage. ... a ...
additional test ... top... and detail was given at the end of
each subject's session. This experiment was meant to determine
if subjects would alter the amount of thematic processing they
perform in response to being oriented toward learning the
specific details of each passage. Figure 3 shows the amount of
thematic processing performed in this experiment. The dashed
line shows the average from similar conditions in the previous
experiment. As the figure shows, there is a considerable
increase in thematic processing with WM span. That is, higher
span readers perform more thematic processing when asked more
questions about details. Apparently, relating each detail to
the theme serves as an effective learning strategy for these
subjects. This is clear from Figure 4, which shows the
relationship between performance on the multiple choice questions
and WM span. There is a general increase in performance with WM
span-- not just an effect on topic or detail questions.

We are now beginning studies that will determine whether lower
span readers can be trained to use the thematic processing
strategies of high span readers in order to increase learning, or
whether their WM capacity limitations make the increased use of
thematic processing an ineffective strategy.

Figure 3:
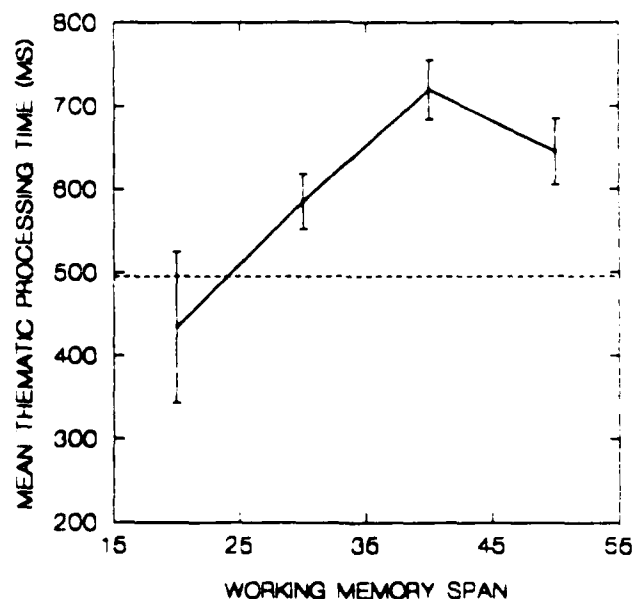
comprehension. For details, see the manuscript included with this report.

REPORTS RESULTING FROM THE GRANT

<u>Conference Presentation</u>

Budd, D. & Whitney, P. (1993). Allocation of working memory while reading expository text. Paper presented at the 34th Annual Meeting of the Psychonomic Society, Washington, D.C.

<u>Manuscript Under Review</u>

Whitney, P. & Budd, D., & Bramucci, R.B. On babies, bath water, and schema theory: A reconsideration of top-down processes in comprehension.

<u>Manuscript in Preparation</u>

Budd, D. & Whitney, P. Allocation of working memory resources during the reading of expository text.

<u>Professional Personnel</u>

The graduate student supported by the AASERT grant was Desiree Budd. She will begin her dissertation this year. It will extend the line of research covered by this grant.

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